

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A video transcoding apparatus comprising:
 - a video decoder to decode a compressed video bit stream so as to restore a pixel value of an original scene;
 - a video pre-processing unit having a predetermined matrix structure and down-sampling a macro block decoded by the video decoder by transforming the macro block into a corresponding picture structure, wherein the video pre-processing unit carries out down-sampling through a field based processing if the data decoded in the video decoder is a frame picture in an interlacing sequence and the video pre-processing unit carries out a down-sampling through a frame based processing if the data decoded in the video decoder is a field picture structure having a sequential scanning sequence or an interlacing sequence;
 - a frame memory storing the down-sampled macro block;
 - a transcoding parameter control unit detecting information about a picture from a previous bit stream variable-length-decoded by the video decoder and setting up an encoding mode for a transcoding in accordance with the detected information;

Reply to Office Action dated April 12, 2006

a video encoder encoding down-sampled data stored in the frame memory by a macro block unit in accordance with the encoding mode set up by the transcoding parameter control unit; and

a bit rate control unit controlling quantization of the video encoder by calculating a bit amount encoded substantially by every picture among a bit stream to be decoded currently by the video decoder and the bit rate control unit determining a fullness of a buffer in the video encoder using the calculated bit amount, wherein the bit rate control unit includes a picture bit counting unit to calculate the bit amount encoded substantially for each picture in the video bit stream that is inputted to the video decoder and to be encoded currently and the picture bit counting unit determines the fullness of the buffer in the video encoder using a target bit number, wherein the target bit number for a picture to be encoded is based on the calculated bit amount calculated by the picture bit counting unit and the video bit stream that is variable-length-coded in the video encoder.

2. (Canceled)

3. (Previously Presented) The apparatus of claim 1, wherein the video pre-processing unit transforms an 8x8 block outputted from the video decoder into a 4x4 block using a following matrix:

Reply to Office Action dated April 12, 2006

$$\begin{bmatrix} y \\ y \\ y \\ y \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = [P4^T] = \begin{bmatrix} X0 \\ X1 \\ X2 \\ X3 \\ X4 \\ X5 \\ X6 \\ X7 \end{bmatrix}$$

, where $[P4] = \begin{bmatrix} T4 & 0 \\ 0 & 0 \end{bmatrix} / \sqrt{2}$, $[T4]$ is a 4-point DCT-based 4*4 DCT matrix, y

denotes down-sampled 4x1 pixels, and X is 8 DCT coefficient blocks.

4. (Original) The apparatus of claim 3, wherein the video pre-processing unit carries out an 1-dimensional down-sampling using a following matrix:

$$y_{[4 \times 1]} = C_4^T \cdot X_{[8 \times 1]} = \begin{bmatrix} T4^T & 0 \end{bmatrix} / \sqrt{2} \cdot [T8] \cdot x_{[8 \times 1]}$$

, where x represents 8x1 pixels, y denotes down-sampled 4x1 pixels, and X is a

DCT coefficient block for x , $T8$ is a 8x8 DCT based matrix, $C_4 = \begin{bmatrix} T4 \\ 0 \end{bmatrix} / \sqrt{2}$, and C_4 is a 4x4

DCT based matrix.

5. (Original) The apparatus of claim 3, wherein the video pre-processing unit carries out a down-sampling of a luminance signal using a following matrix:

$$y_{[4 \times 1]} = C_{4 \times 8} \cdot x_{[8 \times 1]}$$

, where $C_{4 \times 8} = C_4^T \cdot T8$ is a 4x8-dimensional down-sampling matrix and converts 8 pixels into 4 pixels.

6. (Original) The apparatus of claim 3, wherein the video pre-processing unit carries out a down-sampling of a chrominance signal using a following matrix:

$$y_{2 \times 1} = C_{2 \times 4} \cdot x_{[4 \times 1]}$$

, where $C_{2 \times 4} = [T2 \ 0]^T \cdot T4\sqrt{2}$ and T2 is a 2*2 DCT based matrix.

7. (Previously Presented) The apparatus of claim 1, wherein the transcoding parameter control unit establishes a motion vector and a motion mode of the macro block down-sampled by the video pre-processing unit using motion information of the previous bit stream variable-length-decoded by the video decoder.

8. (Previously Presented) The apparatus of claim 1, wherein the transcoding parameter control unit establishes a following video encoding reference and then sets up encoding parameters for a low resolution video of the video encoder:

- 1) maintain a decoded picture coding type;
- 2) maintain a decoded picture structure;
- 3) maintain a decoded GOP (group of pictures);
- 4) vary a decoded motion type or a macro block type;

- 5) vary a decoded quantizing parameter;
- 6) vary a decoded motion vector; and
- 7) vary a decoded VBV_delay and a decoded VBV_buffer_size.

9. (Original) The apparatus of claim 8, wherein the transcoding parameter control unit controls the video encoder so as to intra-code macro blocks outputted from the frame memory if a currently-decoded picture coding type outputted from the video decoder is an I picture.

10. (Original) The apparatus of claim 8, wherein the transcoding parameter control unit determines whether to carry out a motion compensation through types of previously-decoded macro blocks corresponding to the macro block to be encoded currently if the currently-decoded picture coding type outputted from the video decoder is a P or B picture.

11. (Original) The apparatus of claim 10, wherein the transcoding parameter control unit controls the video encoder so as to intra-code the macro block to be encoded currently if at least three intra macro blocks exist in the previously-decoded four macro blocks corresponding to the macro block to be encoded currently.

12. (Original) The apparatus of claim 10, wherein the transcoding parameter control unit controls the video encoder so as to intra-code the macro block to be encoded currently if

two macro blocks in a diagonal direction among four previously-decoded macro blocks corresponding to the macro block to be encoded currently are at intra mode.

13. (Previously Presented) The apparatus of claim 10, wherein the transcoding parameter control unit judges that a motion compensation is necessary if there are other conditions except those described in claims 11 and 12, and then distinguishes the P and B pictures from each other with the picture coding type.

14. (Original) The apparatus of claim 13, wherein average and median values of motion vectors of the previously-decoded macro blocks corresponding to the macro block to be encoded currently are found for the P picture and then the motion vector having a less mean absolute error (MAE) found from two vectors defined by the average value and median value respectively is selected as a motion compensating vector.

15. (Previously Presented) The apparatus of claim 14, wherein the video encoder encodes the macro block to be encoded currently as the intra mode if the selected MAE is greater than a predetermined value, and wherein the video encoder carries out the motion compensation by setting up the macro block type and the motion type fitting for the P picture if the selected MAE is less than the predetermined value and then encodes a difference between the motion-compensated macro block and the macro block to be encoded currently.

16. (Original) The apparatus of claim 13, wherein average and median values of forward and backward motion vectors of the previously-decoded macro blocks corresponding to the macro block to be encoded currently are found for the B picture and then a motion vector at a least one of mean absolute errors (MAE) found from four vectors defined by the average and mean values is selected as a motion compensating vector.

17. (Previously Presented) The apparatus of claim 16, wherein the video encoder encodes the macro block to be encoded currently as the intra mode if the selected MAE is greater than a predetermined value, and wherein the video encoder carries out the motion compensation by setting up the macro block type and the motion type fitting for the B picture if the selected MAE is less than the predetermined value and then encodes a difference between the motion-compensated macro block and the macro block to be encoded currently.

18. (Currently Amended) The apparatus of claim 1, wherein the bit rate control unit comprises:

~~a picture bit counting unit calculating a bit amount encoded substantially for each picture in a video bit stream which is inputted to the video decoder and to be encoded currently, wherein a target bit number for a picture to be encoded is based on the bit amount calculated by the picture bit counting unit and a video bit stream variable length coded in the video encoder and the fullness of the buffer in the video encoder is calculated using the found target bit number;~~

a reference quantizing parameter calculating unit calculating a reference quantizing parameter in accordance with the buffer fullness outputted from the buffer;

an activity calculating unit producing an activity of a video outputted from the video decoder; and

a quantizing parameter generating unit generating a quantizing parameter to be used for a substantial quantization in accordance with the calculated reference quantizing parameter and the calculated activity so as to control a quantization of the video encoder.

19. (Previously Presented) The apparatus of claim 18, wherein the picture bit counting unit detects a picture start code in the video stream inputted to the video decoder and counts to output a bit number between the detected picture start code and a next picture start code.

20. (Original) The apparatus of claim 18, wherein the buffer finds the target bit number $T_2(k)$ in one picture of the video stream to be encoded currently using a following formula:

$$T_2(k) = T_1(k) \times \frac{R_2}{R_1}$$

, where $k \in \{i, p, b\}$, $T_1(k)$ is the target bit number to allocate k-picture to GOP and is found in the picture bit counting unit, R_1 is a bit rate of one sequence of the video stream inputted to the video decoder, and R_2 is a bit rate of one sequence of the video stream to be encoded.

Reply to Office Action dated April 12, 2006

21. (Previously Presented) The apparatus of claim 20, wherein the buffer finds the buffer fullness (d_j^i, d_j^p, d_j^b) of the respective pictures using a following formula:

$$d_j^i = d_0^i + B_{j-1} - \left\{ \frac{T_{2i} \times (j-1)}{MB_cnt} \right\};$$

$$d_j^p = d_0^p + B_{j-1} - \left\{ \frac{T_{2p} \times (j-1)}{MB_cnt} \right\}; \text{ and}$$

$$d_j^b = d_0^b + B_{j-1} - \left\{ \frac{T_{2b} \times (j-1)}{MB_cnt} \right\}$$

, where each of d_0^i, d_0^p, d_0^b shows an initial fullness of a buffer of each of the pictures, B_j is a bit number generated from encoding macro blocks up to the present including j , and MB_cnt represents a total number of the macro blocks in the picture.

22. (Previously Presented) The apparatus of claim 18, wherein the activity calculating unit receives an output of the frame memory, determines the activity of the macro block to be encoded currently, normalizes the activity, and outputs the normalized activity to the quantizing parameter generating unit, and wherein an initial value of an average value of the activities used for the activity normalization is set up by finding an average activity of a macro block to be decoded into an original resolution.

23-29. (Canceled).

Reply to Office Action dated April 12, 2006

30. (Currently Amended) A video transcoding apparatus comprising:

- a video decoder to decode a video bit stream;
- a video pre-processing unit to down-sample a macro block decoded by the video decoder, wherein the video pre-processing unit carries out down-sampling through a field based processing if the data decoded in the video decoder is a frame picture in an interlacing sequence and the video pre-processing unit carries out a down-sampling through a frame based processing if the data decoded in the video decoder is a field picture structure having a sequential scanning sequence or an interlacing sequence;
- a frame memory to store the down-sampled macro block;
- a transcoding parameter control unit to detect information about a picture from a previous bit stream variable-length-decoded by the video decoder and to determine an encoding mode based on the detected information;
- a video encoder to encode the down-sampled data stored in the frame memory by macro block units based on the encoding mode output from the transcoding parameter control unit; and
- a bit rate control unit to control a quantization of the video encoder by calculating a bit amount among ~~a~~the bit stream to be decoded currently by the video decoder and the bit rate control unit to determine a fullness of a buffer in the video encoder based on the calculated bit amount, wherein the bit rate control unit includes a picture bit counting unit to calculate the bit amount encoded substantially for each picture in the bit stream that is inputted to the video decoder and to be encoded currently and the picture bit counting unit to calculate the fullness of

Reply to Office Action dated April 12, 2006

the buffer in the video encoder using a target bit number, wherein the target bit number for a picture to be encoded is based on the calculated bit amount calculated by the picture bit counting unit and the video bit stream that is variable-length-coded in the video encoder.

31. (Canceled).

32. (Previously Presented) The apparatus of claim 30, wherein the video pre-processing unit transforms a block output from the video decoder into a smaller block.

33. (Previously Presented) The apparatus of claim 30, wherein the video pre-processing unit carries out an 1-dimensional down-sampling.

34. (Previously Presented) The apparatus of claim 30, wherein the video pre-processing unit carries out a down-sampling of a luminance signal.

35. (Previously Presented) The apparatus of claim 30, wherein the video pre-processing unit carries out a down-sampling of a chrominance signal.

36. (Previously Presented) The apparatus of claim 30, wherein the transcoding parameter control unit establishes a motion vector and a motion mode of the macro block

Reply to Office Action dated April 12, 2006

down-sampled by the video pre-processing unit using a motion information of a previous bit stream variable-length-decoded by the video decoder.

37. (Previously Presented) The apparatus of claim 30, wherein the transcoding parameter control unit controls the video encoder so as to intra-code macro blocks output from the frame memory when a currently-decoded picture coding type outputted from the video decoder is an I picture.

38. (Previously Presented) The apparatus of claim 30, wherein the transcoding parameter control unit determines to carry out a motion compensation through types of previously-decoded macro blocks corresponding to the macro block to be encoded currently when the currently-decoded picture coding type output from the video decoder is a P picture or a B picture.

39. (Previously Presented) The apparatus of claim 38, wherein the transcoding parameter control unit controls the video encoder so as to intra-code the macro block to be encoded currently when at least three intra macro blocks exist in the previously-decoded four macro blocks corresponding to the macro block to be encoded currently.

40. (Currently Amended) The apparatus of claim 1, wherein the bit rate control unit comprises:

[[a]] the picture bit counting unit to calculate a bit amount encoded substantially for each picture in a video bit stream input to the video decoder;

a reference quantizing parameter calculating unit to calculate a reference quantizing parameter in accordance with a buffer fullness;

an activity calculating unit to produce an activity of a video output from the video decoder; and

a quantizing parameter generating unit to generate a quantizing parameter to be used for a substantial quantization in accordance with the calculated reference quantizing parameter and the calculated activity so as to control a quantization of the video encoder.

41. (Previously Presented) The apparatus of claim 40, wherein the picture bit counting unit detects a picture start code in the video stream input to the video decoder and outputs a bit number based on the detected picture start code and a next picture start code.

42. (Currently Amended) A video apparatus comprising:

a video decoder to decode a video bit stream;

a video pre-processing unit to down-sample a macro block decoded by the video decoder, wherein the video pre-processing unit to perform down-sampling using a field based processing when the data decoded in the video decoder corresponds to a frame picture and the

Reply to Office Action dated April 12, 2006

video pre-processing unit to perform a down-sampling using a frame based processing when the data decoded in the video decoder corresponds to a field picture structure;

a frame memory to store the down-sampled macro block; ~~and~~

a transcoding parameter control unit to detect information about a picture from a previous bit stream decoded by the video decoder and to set up an encoding mode based on the detected information;

a video encoder to encode data stored in the frame memory by macro block units in accordance with the encoding mode set up by the transcoding parameter control unit; and

a bit rate control unit to control the video encoder by calculating a bit amount encoded by every picture among the bit stream to be decoded currently by the video decoder and the bit rate control unit to determine a fullness of the video encoder based on the calculated bit amount, wherein the bit rate control unit includes a picture bit counting unit to calculate the bit amount encoded substantially for each picture in the bit stream that is inputted to the video decoder and is to be encoded currently, wherein the fullness of the buffer in the video encoder is calculated using a target bit number, and the target bit number for a picture to be encoded is based on the bit amount calculated by the picture bit counting unit and the bit stream that is variable-length-coded in the video encoder.

43-44. (Canceled)

Reply to Office Action dated April 12, 2006

45. (Previously Presented) The video apparatus of claim 42, wherein the video pre-processing unit performs down-sampling using the field based processing when the data corresponds to the frame picture in an interlacing sequence.

46. (Previously Presented) The video apparatus of claim 42, wherein the video pre-processing unit performs down-sampling using the frame based processing when the data corresponds to the field picture structure having a sequential scanning sequence or an interlacing sequence.

47. (Previously Presented) The video apparatus of claim 42, wherein the video pre-processing unit transforms an 8x8 block into a 4x4 block.

48. (Previously Presented) The video apparatus of claim 47, wherein the video pre-processing unit transforms the 8x8 block into the 4x4 block using a following matrix:

$$\begin{bmatrix} y \\ y \\ y \\ y \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = [P4^T] = \begin{bmatrix} X0 \\ X1 \\ X2 \\ X3 \\ X4 \\ X5 \\ X6 \\ X7 \end{bmatrix}$$

Reply to Office Action dated April 12, 2006

, where $[P4] = \begin{bmatrix} T4 & 0 \\ 0 & 0 \end{bmatrix} / \sqrt{2}$, $[T4]$ is a 4-point DCT-based 4*4 DCT matrix, y

denotes down-sampled 4x1 pixels, and X is 8 DCT coefficient blocks.

49. (Currently Amended) A video transcoding apparatus comprising:

a video decoder to decode a video bit stream; and

a video pre-processing unit to down-sample data using a field based processing when the data decoded in the video decoder corresponds to an interlacing sequence having a frame picture and to down-sample data using a frame based processing when the data decoded in the video decoder is a sequential scanning sequence or an interlacing sequence having a field picture structure;

a video encoder to encode the down-sampled data by macro block units based on the determined encoding mode; and

a bit rate control unit to control the video encoder by calculating a bit amount of the bit stream to be decoded by the video decoder and the bit rate control unit to determine a fullness of the video encoder based on the calculated bit amount and a target bit number, wherein the bit rate control unit includes a picture bit counting unit to calculate the bit amount encoded substantially for each picture in the bit stream that is inputted to the video decoder and to be encoded currently, wherein the target bit number for a picture to be encoded is based on the bit amount calculated by the picture bit counting unit and the bit stream that is variable-length-coded in the video encoder.

Serial No. **10/034,380**

Docket No. **K-0387**

Reply to Office Action dated April 12, 2006

50. (Previously Presented) The video transcoding apparatus of claim 49, further comprising:

a transcoding parameter control unit to detect information about a picture from another bit stream and to determine an encoding mode based on the detected information.

51-52. (Canceled)